VIDEO LIFE™

GAME INSTRUCTIONS

GETTING STARTED

Video Life is an unusual video game. The object of playing Video Life is not to achieve a high score, but rather to create beautiful, changing patterns from simple beginnings. Detailed instructions, hints, and the game's history are given later. Here is how you can get started with Video Life.

- Make sure your Video Computer System is turned off and connected properly to your TV.
- Connect both joysticks, insert the Video Life cartridge, set both difficulty switches down ("b" position), and turn on the game.
- The game will write the word "Life" on the TV screen, erase the word, and then show a changing pattern of small dots.

This is a built-in demonstration of how the rules of Video Life allow a small starting pattern of dots to grow into complex patterns that fill the screen. After watching the demonstration, you will want to try your own patterns. Just follow these steps:

- Depress **and hold** the **GAME RESET SWITCH** until a ragged line moves down the TV screen, erasing the small dots.
- Move the single remaining bright dot around the screen with the **LEFT JOYSTICK.** If the fire button is depressed, the bright dot will leave a trail of dots behind it as it moves. Notice that it will also erase dots if they are already present.
- Using the **LEFT JOYSTICK,** draw a picture on the TV screen. Even simple patterns like squares, diamonds, or long straight lines will produce interesting and surprising results.
- Press the **FIRE BUTTON** on the **RIGHT JOYSTICK** and your picture will begin to grow into new patterns.

Some interesting patterns to try can be found later in this manual in the section called "Classical Patterns in Life". Before looking there, you can enjoy experimenting with simple patterns of your own. Observe how adding or removing a single dot from a starting pattern can make the difference between the dots rapidly dying out or expanding to fill the screen!

What Video Life does is to take your starting pattern of dots, examine the placement of dots in the pattern, and produce a new (and probably different) pattern. This new pattern is then used to make yet another new pattern. New patterns will continue to be made from old at a rate of about one per second.

Each time a new pattern has been made, we say that a new "generation" of dots is one the screen. The placement of dots in the new generation is found by looking at exactly where the dots are in the old generation, and applying some rules. The rules for going from one generation to the next are discussed in the section "The Rules of Video Life". Even without understanding the rules, it is fun to watch the changing patterns and listen to the musical tones.

You can stop the growth of the pattern at any time by moving the **LEFT JOYSTICK** in any direction. Once the growth has been stopped, the pattern can be changed and growth resumed. Changing the pattern is done by moving the bright dot (using the **LEFT JOYSTICK**) to those places on the screen where you wish to add new dots or to remove old dots. The old dot is removed or the new dot added by pressing the **FIRE BUTTON** on the **LEFT JOYSTICK.** After you have made your changes, the growth can be resumed by pressing the **FIRE BUTTON** on the **RIGHT JOYSTICK.**

If you wish to make a completely new pattern, press the **GAME RESET SWITCH** until a ragged line starts to move down the screen. This will clear the screen of all dots. You can then use the **LEFT JOYSTICK** to make a new pattern. Press the **FIRE BUTTON** on the **RIGHT JOYSTICK** to start the new pattern growing.

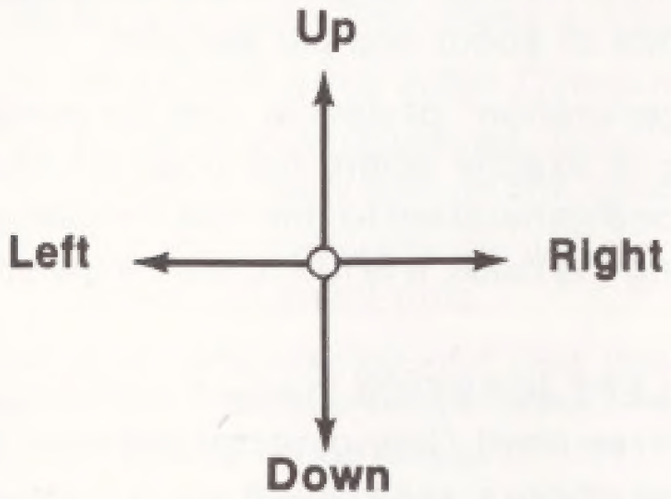
To speed up the growth, flip up (into the "a" position) the **LEFT DIFFICULTY SWITCH.** This also makes the TV picture flicker and changes the musical tones that are produced. The course of growth, and the final state of the pattern are, however, **not** changed.

If Video Life is left turned on, but not changing generations for more than ten minutes, the TV picture will begin to change colors rapidly. This flashing will stop as soon as you resume playing the game.

DETAILS OF GAME OPERATION

LEFT JOYSTICK ACTION

The **LEFT JOYSTICK** controls the position of the bright dot on the TV screen.



How LEFT JOYSTICK Moves the Bright Dot

Its **FIRE BUTTON** is used to add or remove a dot from the screen at the location of the bright dot. The easiest way to move the bright dot is to hold the joystick in your left hand with the **FIRE BUTTON** on the left side and toward the TV. The **FIRE BUTTON** is then easily pressed with your left thumb. This is the same way the joystick is normally held for other games. Notice that when the joystick is pushed, the bright dot moves one space and then hesitates before moving again. This hesitation will allow you to position the dot exactly where you want it by tapping the joystick. A dotted line can be drawn by tapping the **FIRE BUTTON** while the joystick is held in one direction.

Notice also that the bright dot moves smoothly off one edge of the dot display and reappears on the opposite edge. This is called "wrap around". The bottom edge of the dot display can be thought of as being connected to the top edge, and the left edge of the dot display can be thought of as being connected to the right edge. This means that a pattern that is growing close to an edge of the dot display may spill over to the opposite edge.

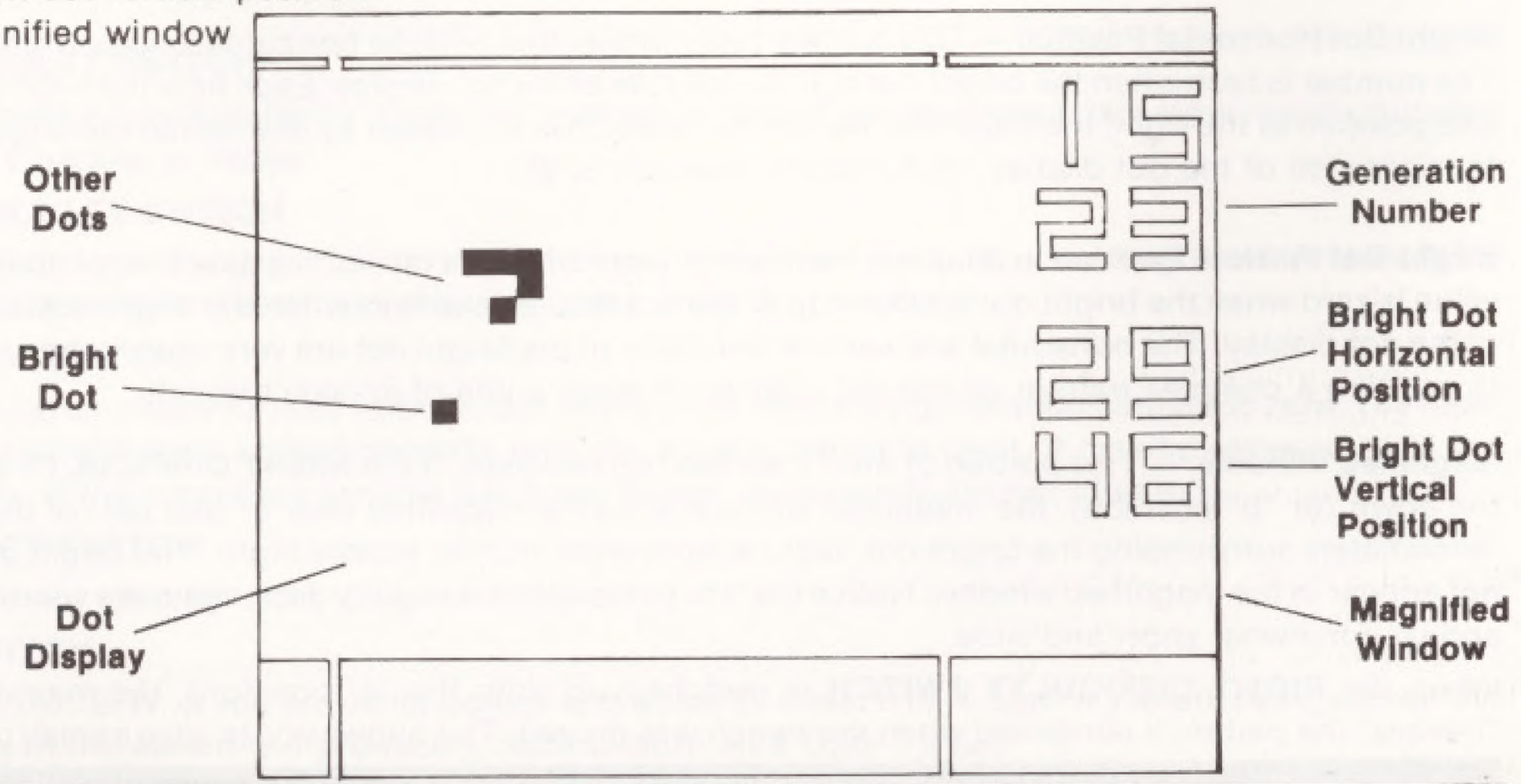
RIGHT JOYSTICK ACTION

The **RIGHT JOYSTICK** can be used to stop the updating of successive pictures (generations). Moving the stick in any direction will stop updating the picture. Pressing the **FIRE BUTTON** will start it again. By holding the right stick in any direction and tapping the **FIRE BUTTON** once, a single generation of alterations to the picture can be produced.

APPEARANCE OF THE TV SCREEN

The display on the TV screen is made up of five parts:

- The dot display
- The generation number
- The bright dot horizontal position
- The bright dot vertical position
- The magnified window



Dot Display — The dot display is that part of the TV screen in which the bright dot can be moved with the **LEFT JOYSTICK.**

Generation Number — The generation number shows how many generations a pattern has been through. For example, if the generation number on the TV screen looks like this:

15
23

then the pattern is the dot display has gone through 1523 generations. The generation number is set to zero whenever Video Life is reset using the **GAME RESET** switch.

Bright Dot Horizontal Position — This is a two digit number that tells the horizontal position of the bright dot. The number is zero when the bright dot is at the left side of the dot display. Each time the bright dot is moved one position to the right, the bright dot horizontal position is increased by one. When the bright dot is at the far right side of the dot display, its horizontal position is 95.

Bright Dot Vertical Position — This is a two digit number that tells the vertical position of the bright dot. Its value is zero when the bright dot is at the top of the dot display and is 79 when the bright dot is at the bottom of the dot display. The horizontal and vertical positions of the bright dot are very useful when you are trying to position a complex pattern on the dot display, or draw a line of an exact length.

Magnified Window — This portion of the TV screen has two uses. If the **RIGHT DIFFICULTY SWITCH** is in the down (or "b" position), the magnified window shows a magnified view of that part of the dot display immediately surrounding the bright dot (eight spaces wide and ten spaces high). The bright dot itself does **not** appear in the magnified window. Notice that the perspective is slightly different in the window—patterns appear somewhat short and wide.

When the **RIGHT DIFFICULTY SWITCH** is switched up (into the "a" position), the magnified window "freezes" the pattern it contained when the switch was moved. This allows you to save a small part of the dot

display. The frozen pattern in the window can then be copied onto any part of the dot display. This is done by:

- Moving the bright dot to the place on the dot display where you wish to copy the window.
- Holding the **RIGHT JOYSTICK** in any direction **and** pressing the **FIRE BUTTON** on the **LEFT JOYSTICK.**

This is a bit awkward but is very useful for filling the dot display with many copies of a small pattern. Another use is to freeze an empty pattern in the window. This empty pattern can then be copied onto portions of the dot display to selectively erase portions of a large pattern.

LEFT DIFFICULTY SWITCH

Flipping this switch "up (into the "a" position)" makes the pattern generations update more rapidly, but also causes the TV picture to flicker.

RIGHT DIFFICULTY SWITCH

Moving this switch into the up (or "a") position "freezes" the current contents of the magnified window. For a more detailed description, see the discussion of the magnified window.

GAME RESET SWITCH

Pressing this switch clears all dots from the dot display and resets the generation number to zero. The reset switch must be held down several seconds until the screen begins to clear. It may be released once the clearing starts. If the magnified window has been frozen, its contents are not affected.

GAME SELECT SWITCH

This switch is not used by Video Life.

TV TYPE SWITCH

Set this switch to "B/W" if you are using a black and white TV or set it to "Color" if you are using a color TV. Either setting of the switch will produce a color picture on a color TV set.

THE RULES OF VIDEO LIFE

Video Life can be played with little or no thought about its underlying rules. Understanding them will, however, help you develop an intuition about finding interesting patterns.

As previously stated in the "Getting Started" section, Video Life follows rules to determine the dot pattern in the new generation from the dot pattern in the old generation. To understand these rules, first think of the dot display as a giant checkerboard. Each square on this checkerboard either contains a colored dot or is empty. Also, each square on the checkerboard is surrounded by eight neighboring squares:

1	2	3
4		5
6	7	8

Each square has eight neighboring squares.

Video Life produces a new generation by examining each square in the old generation and applying the following rules.

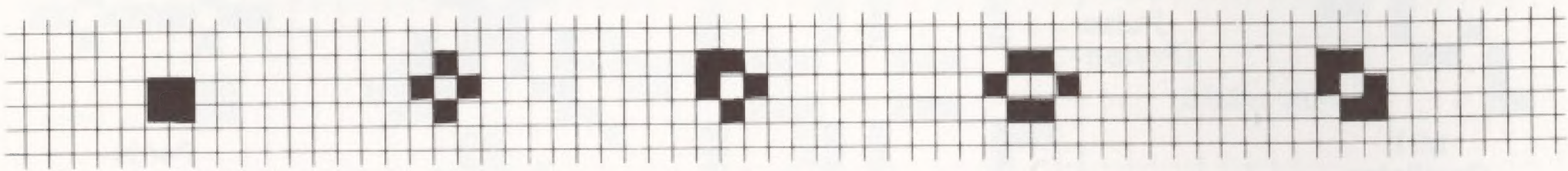
1. If a square contains a dot and has **one or zero** dots in its neighboring squares, it becomes empty (dies of loneliness) in the new generation.
2. If a square contains a dot and has **more than three** dots in its neighboring squares, it becomes empty (dies of overcrowding) in the new generation.
3. If a square contains dot and has **two or three** dots in its neighboring squares, the dot remains (survives) in the new generation.
4. If a square is empty and **exactly three** of its neighboring squares are occupied, the square will contain a dot (gives birth) in the new generation.

You can apply these rules by hand and follow the development of simple patterns, although Video Life is faster and never makes mistakes. To help you to understand the rules, apply them to a small pattern, and compare your results to what Video Life gets when it develops the pattern. A good pattern to try is three dots in a row. Remember to examine only the dots in the current generation in determining the next generation. It is also helpful to remember that if you hold the **RIGHT JOYSTICK** in any direction and momentarily push its **FIRE BUTTON,** Video Life will produce the next generation and then stop.

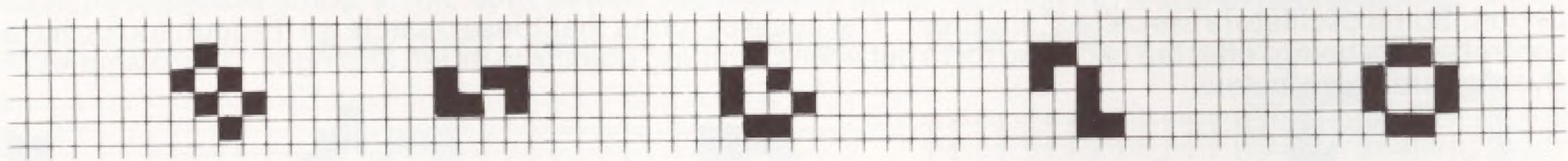
CLASSICAL PATTERNS IN LIFE

Although Video Life will evolve any picture or pattern you create, certain types of patterns are known to produce particularly interesting results. We review some of them here, along with the names given them by early Life investigators. Notice that some of the complex patterns are composed partly of carefully positioned copies of smaller patterns. The combining of familiar pieces is a productive way of generating new, interesting patterns.

Still Lifes: — These patterns just sit there! They will often appear as part of the development of a larger, more complex pattern:



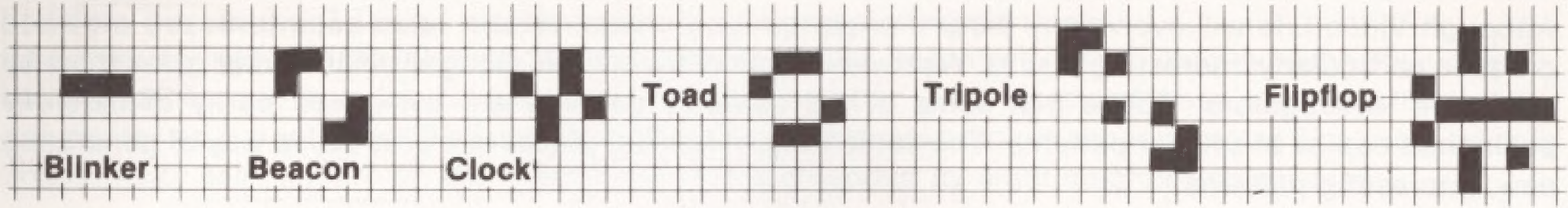
Block **Tub** **Boat** **Beehive** **Ship**

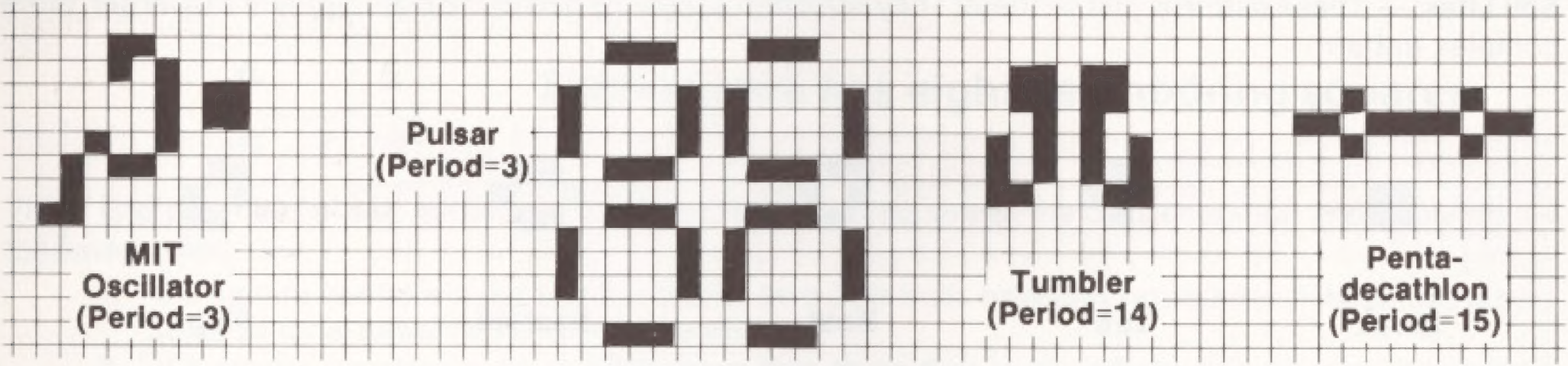


Barge **Snake** **Burloaf** **Period 3 eater** **Pond**

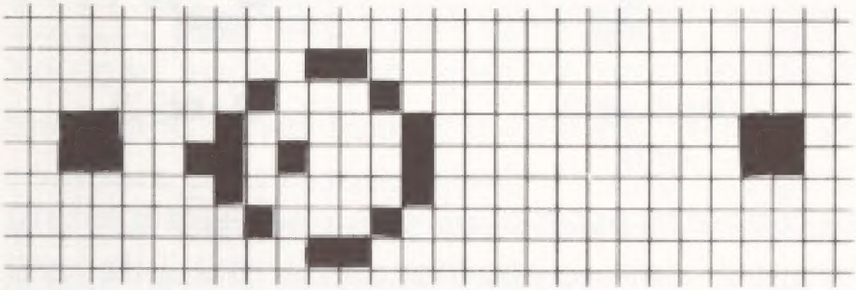
Many more "Still Lifes" exist. Sometimes placing two "Still Lifes" close to each other can cause interesting things to happen. For example, placing a "Block" or a "Period 3 eater" next to another small "Still Life" will often cause the other "Still Life" to be destroyed.

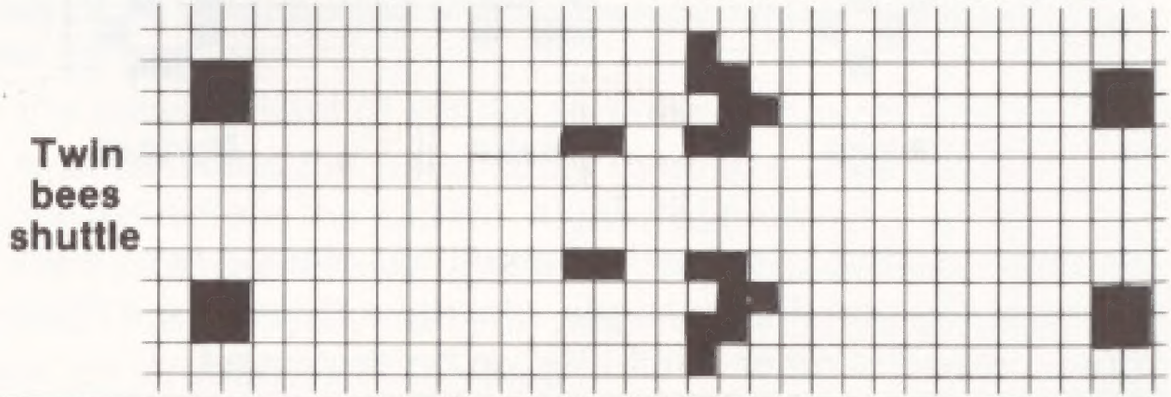
Oscillators: — These patterns go through a cycle of forms before returning to the original pattern. The cycle of forms is then repeated again and again. The number of forms in the cycle is called the "period" of the oscillator.



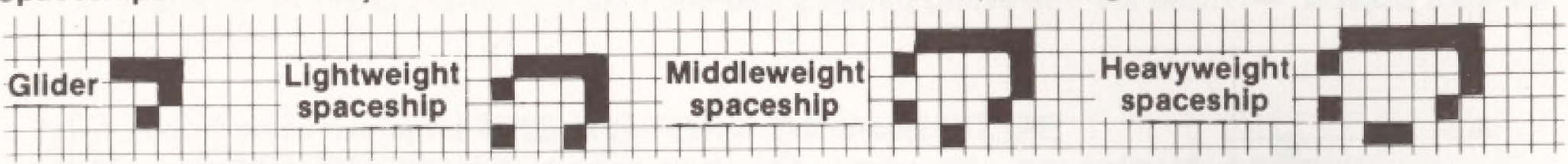


The pentadecathlon can "eat" or "reflect" gliders (discussed below) that "hit" it at the proper form in its period. Some oscillators are called "shuttles". The cycle of forms that these objects go through looks like a central object being reflected back and forth between confining objects to its left and right. Two examples of shuttles are given below:



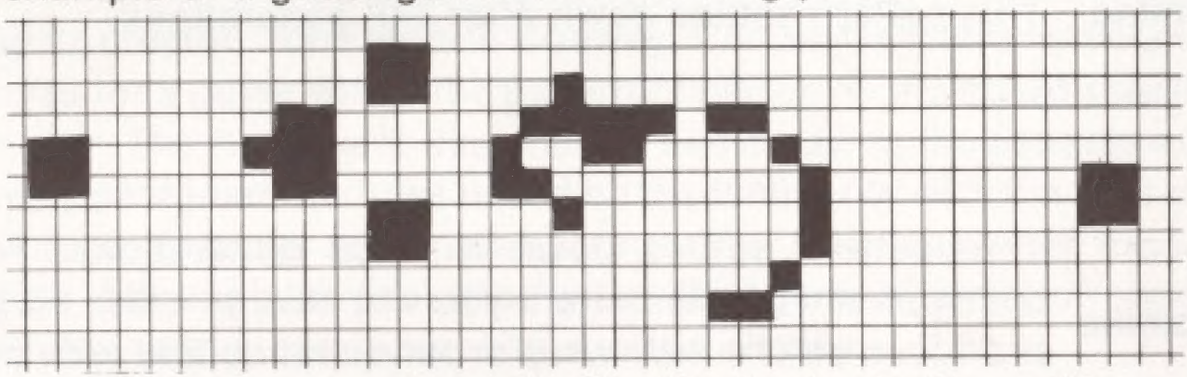


Spaceships: — These objects move across the screen. Four examples are given below:



Other, much larger, moving objects can be built from "fleets" of closely positioned spaceships shepherding a large central object. Gliders can be set on collision courses with sometimes spectacular results.

Glider Guns: — Several patterns exist that periodically "shoot" out a glider. Such patterns are called "glider guns". One example of a glider gun is the following pattern:

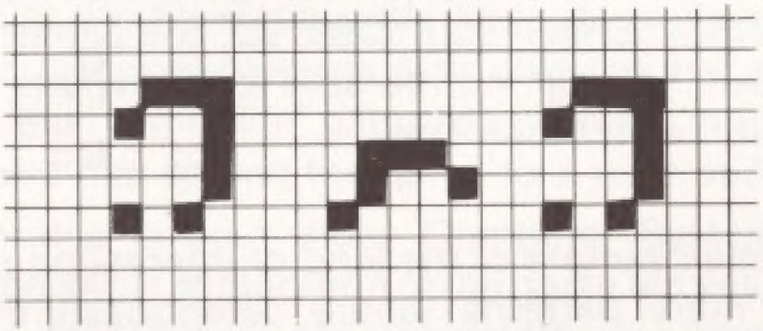


Glider gun

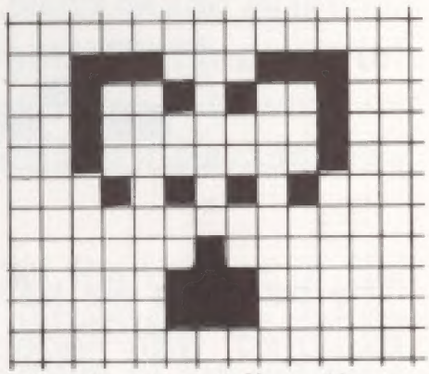
This glider gun pattern is almost identical to the basic shuttle pattern.

Puffer Trains: — Several patterns exist that move across the screen leaving a trail of debris behind. These patterns are called "puffer trains". Here are two examples of puffer trains:

Puffer train #1

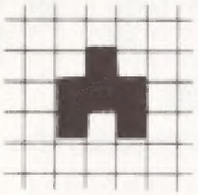


Puffer train #2

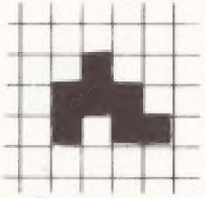


Notice that both of these puffer trains are made by combining two spaceships with another small pattern.

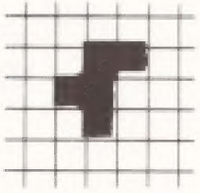
Random Objects: — These are interesting patterns that don't fall into other classes of objects.



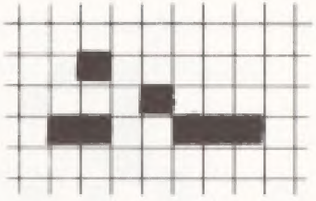
Blasting cap This is the pattern that is placed on the screen when Video Life is first turned on. The name given to it by the MIT Artificial Intelligence Group! The pattern settles down after 173 generations.



B heptomino This pattern settles down after 148 generations.



R pentomino This pattern settles down in 1103 generations. To follow the development of this pattern you will have to erase six gliders that it produces before they wrap around and collide with the rest of the pattern.



Acorn For its size, this pattern goes through the most generations before it settles down. Even if you "clean up" the pattern as it wraps around the screen, you will not be able to follow this whole pattern to its conclusion with Video Life!!

The patterns we have given here are only a small sample of the kind of interesting patterns that can be explored with Video Life. There are many more patterns (entire categories!) that have also been discovered—and just think of all those that nobody has even seen yet!

THE HISTORY OF VIDEO LIFE

For many years, Martin Gardner has written a column entitled "Mathematical Games" in the magazine **Scientific American.** In the October, 1970 issue, his column was devoted to a new solitaire board game called "life" by its creator, John Horton Conway. Conway, a mathematician at the University of Cambridge, had created rules for a game where the pattern of pieces on the board specified a new descendant pattern in a very simple way. The rules were designed to avoid having the patterns either grow explosively or die out quickly. Conway designed the rules based on his familiarity with the field of mathematics that underlies all games of this type: "cellular automata theory". The rules were just those we gave for Video Life in the previous section. Although they could be used with a game board or on paper, some of Conway's associates soon put the rules onto a computer with a video display.

Preliminary investigations of the game by Conway and others soon confirmed the richness of the possible patterns. Once the game had been publicized in Martin Gardner's column, an unprecedented burst of activity followed at computer centers all over the world. At some univeristy centers, such as the Artificial Intelligence Project at the Massachusetts Institute of Technology, teams of investigators with powerful computers began to discover patterns with unusual and striking properties. In the decade following its introduction, the interest in the "life" game has naturally moderated, but new enthusiasts and the availability of personal computers has spread the game to a wide audience.

The Video Life cartridge in your Video Computer System is actually more powerful than some of the computers used in the initial exploration of the game ten years ago. Most of the classic patterns of life can be recreated on Video Life. Not only can you create your own patterns, but you can try most of the patterns available in the extensive, but scattered, literature on the game. If you are interested in more information on

the game, here are some references:

Martin Gardner's column in **Scientific American** dealt at least in part with the life game on a number of occasions. Some of them are:

October and November 1970
January, February, March, April and November 1971
January 1972

BYTE Magazine has had numerous articles about the life game over the years. One of the best is: "Some Facts of Life" by David J. Buckingham, December 1978.

A new book entitled **Winning Ways** by John Horton Conway, Richard Guy and Elwyn Berlekamp is due to be published soon by Academic Press, London. The life game will be featured in chapter 25 of this book.